Agricultural Extension Service ● University of Minnesota

FACT SHEET

FOOD SCIENCE AND INDUSTRIES NO.15

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BACTERIA

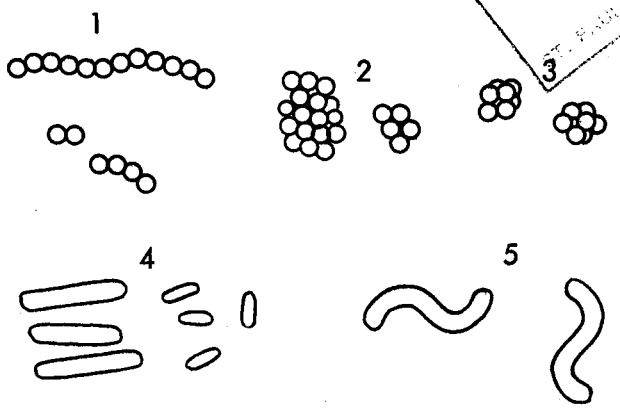

Figure 1. Different forms of bacteria: 1. Streptococcus. 2. Micrococcus. 3. Sarcina. 4. Rod forms. 5. Spirillum.

Bacteria are small, single-celled, living organisms. Although the cells are of many shapes, the three basic forms are round or spherical, cylindrical or rod shaped, and spiral (see figure 1).

Bacteria are so small that you cannot see them with the naked eye--you must use a microscope that magnifies about 1,000 times. If a 6-foot man was magnified 1,000 times, he would appear over 1 mile tall. One cubic inch would hold more than 8 trillion bacteria and 400 million could fit into the space occupied by a grain of sugar.

How Bacteria Grow

Growth of bacteria normally takes place by cell division; that is, one cell becomes two, two become four, four become eight, and so on (see figure 2). When we speak of growth of bacteria, we do not mean an increase in size but an increase number. The rate at which growth occurs varies with different bacteria and is affected by numerous factors.

Temperature

Temperature variation is the most widely used method of controlling bacterial growth. Bacteria can grow over a wide temperature range and are classified roughly according to the temperatures at which they grow.

Mesophilic bacteria grow best at about 80°-90° F. However, their growth temperatures vary from 60° to 110° F. Most bacteria belong to this temperature group.

Thermophilic bacteria grow at 110°-150° F. temperatures.

Psychrophilic bacteria grow in the cold (in a refrigerator) but usually grow best at higher temperatures. They will grow at temperatures from 35° to 90° F.

By varying the temperature, growth can be enhanced or inhibited or the bacteria can be destroyed. You can pasteurize material by increasing the temperature to a point where pathogenic (disease-producing) bacteria are killed; you can sterilize it by increasing the temperature until all bacteria are killed. For example, to pasteurize fluid milk, you must keep it at 145° F. for 30 minutes or at 161° F. for 16 seconds. To sterilize it, you must keep it at 250° F. for 15 minutes.

Growth of bacteria can be inhibited by reducing the temperature to below 45° F. This method is utilized daily by the housewife when she places food in her refrigerator.

Water

Growth--of bacteria, man, or tree--can occur only if water is present. The food for bacteria dissolves in water. Without this process the food could not enter the cells where it is used for energy or for synthesis of new cell matter. Water enters directly into many chemical reactions necessary for the life processes; it also carries waste products from the cell.

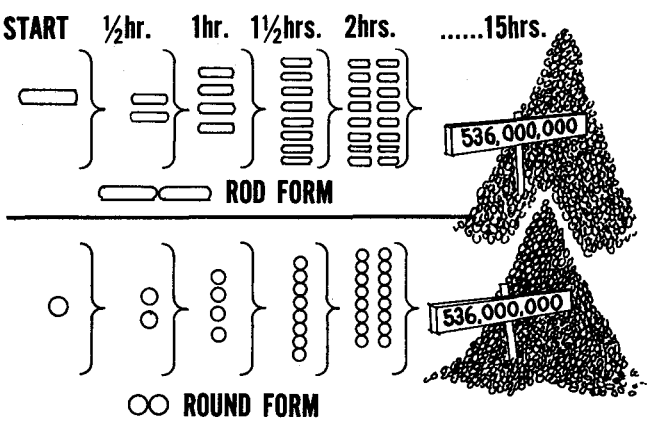

Figure 2. How bacteria grow.

Food

Bacteria depend upon food containing energy sources, substances that make up cell matter, and minerals. Various bacteria need markedly different types of food for growth. Some bacteria can grow on only ammonium salts, glucose, water, and inorganic ions. Other bacteria require a complex food including vitamins, minerals, and amino acids.

Oxygen

Some bacteria (aerobic) grow only if oxygen is present; others (anaerobic) grow only if it is not. But many bacteria (facultative anerobes) grow under either condition.

pH

The term pH refers to the amount of acid or alkali in a food. The scale ranges from O to 14 with 7 considered neutral, below 7 considered acid, and above 7 considered alkaline. Although most bacteria grow best at a neutral pH, many grow over a 4.5-10.0 pH range.

Inhibitors

Many substances, either chemical or derived from nature, prevent bacterial growth. These substances, such as chemical sanitizers and antibiotics, are quite numerous and their effects on bacteria vary.

Useful Bacteria

Although many people believe otherwise, most forms of bacteria do not produce disease. They live in various places in nature, growing wherever they find the proper conditions. In some cases, their activities may not significantly affect the surrounding environment; in others, they perform changes of immeasurable benefit.

Many thousands of useful activities are performed by bacteria including: production of acid and flavor in the manufacture of butter, cheese, and buttermilk; fixation of atmospheric nitrogen in soil; production of vinegar from alcohol; decomposition of waste; and buildup of soil through various activities.

Pathogenic Bacteria

A relatively small proportion of bacteria can produce diseases and are a constant hazard to man, animals, and plants (the hosts). They produce such diseases by growing on or in certain tissues of the host and, thereby, injuring him. Or they produce harmful poisons called toxins on or in the host or in foods that the host eats later. (See Food Microbiology Fact Sheet No. 1, Bacterial Food Poisoning.)

Spoilage Bacteria

In their attempt to live and perpetuate themselves, many bacteria produce changes in food products that damage flavor and composition. They can sour milk, spoil meat, turn vinegar bitter, and ruin many other food items. Therefore, from the time a food is produced and processed, there is a constant race between the producer, the processor, the consumer, and the bacteria. If the bacteria win, the food is damaged.

Spore-Forming Bacteria

While certain bacteria grow, they develop a more resistant state known as a spore or endospore. The vitality of the actively growing cell is transferred to the spore. The spore increases the organism's capacity to survive in unfavorable environments such as extreme heat, cold, dryness, and chemical concentration. The spore state can be considered as a "resting" state of the organism; as such, it can survive much longer than the vegetative or actively growing cell. Since the spore is so much more resistant to adverse conditions, sterilization techniques such as used in the canning of food are based on conditions necessary to destroy spores. Under proper conditions, the spore can initiate growth and become an actively growing cell once again.

We become aware of bacteria not by their appearance but by the changes in our environment that they cause. These changes, either desirable or undesirable, are due to bacterial growth and can be controlled.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Roland H. Abraham, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55101.